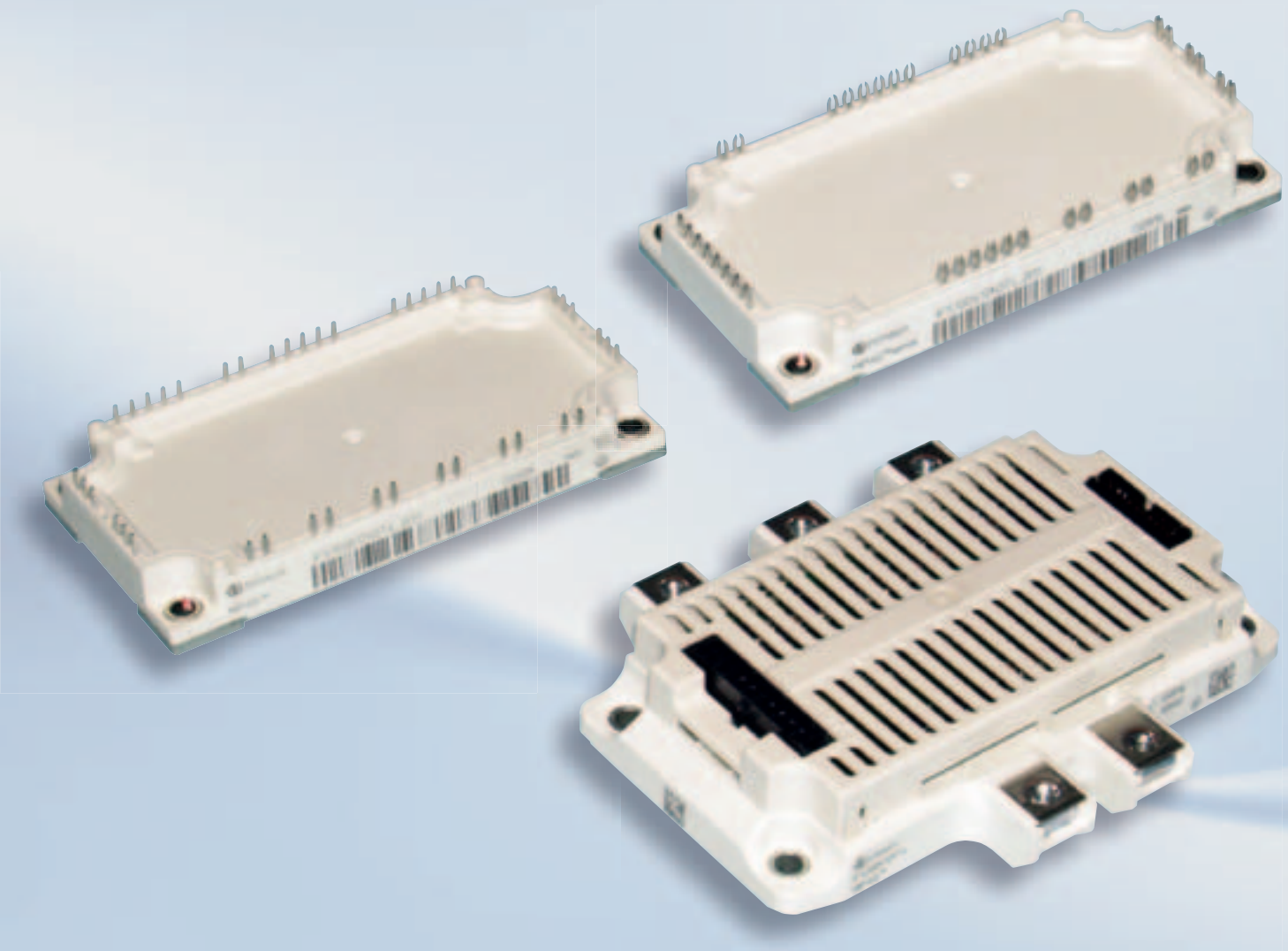


MIPAQ™ – More Than You Expect!

Infineon's functional IGBT module family

[www.infineon.com/mipaq]

MIPAQ™ Family

Applications

The MIPAQ™ modules enable highly efficient power inverter designs to be used in

- Industrial drives, such as compressors, pumps and fans
- Uninterruptible Power Supply (UPS)
- Air conditioning systems
- Solar inverters

The modules are characterized by enhanced testing and are delivered as known-good systems.

MIPAQ™ IS A NEW FUNCTIONAL product family and dedicated to useful integration of electronics into power modules.

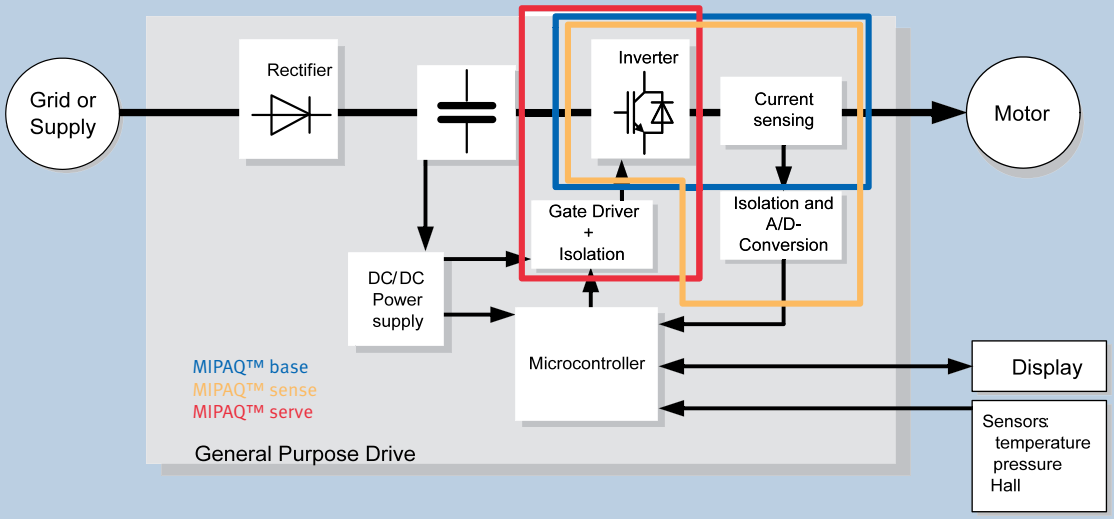
THE MIPAQ™ FAMILY was developed in order to offer Modules Integrating Power, Application and Quality. It is a functional product family within Infineon's IGBT modules portfolio. The combination of an IGBT module and the integration of sensing and driving electronics leads to an optimized solution in mastering the challenge of designing powerful and compact inverters for low and medium power at low costs, contributing to energy savings to improve profitability and protect our environment at the same time.

THE MIPAQ™ FAMILY includes three products and offers significant board space savings.

- MIPAQ™ base
- MIPAQ™ sense
- MIPAQ™ serve

THE MIPAQ™ BASE MODULE integrates shunts, while the MIPAQ™ sense module offers an additional current measurement feature that is fully digital with galvanically isolated output signals, and the MIPAQ™ serve module includes driver electronics.

Integration Level



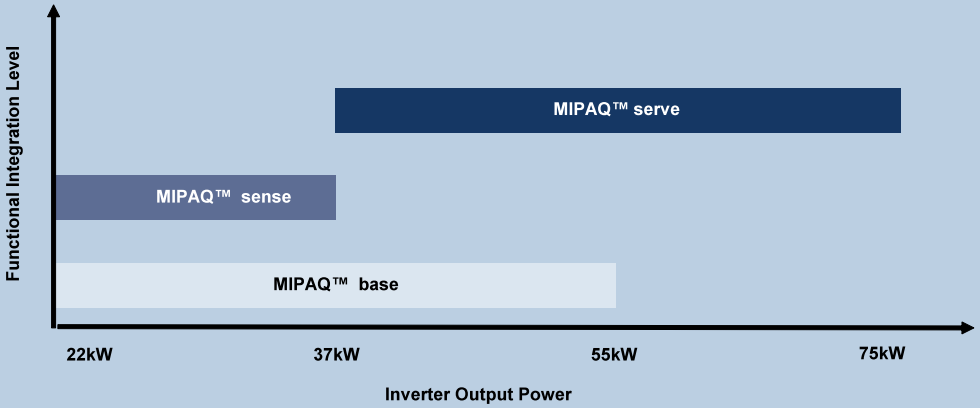
Chip technology

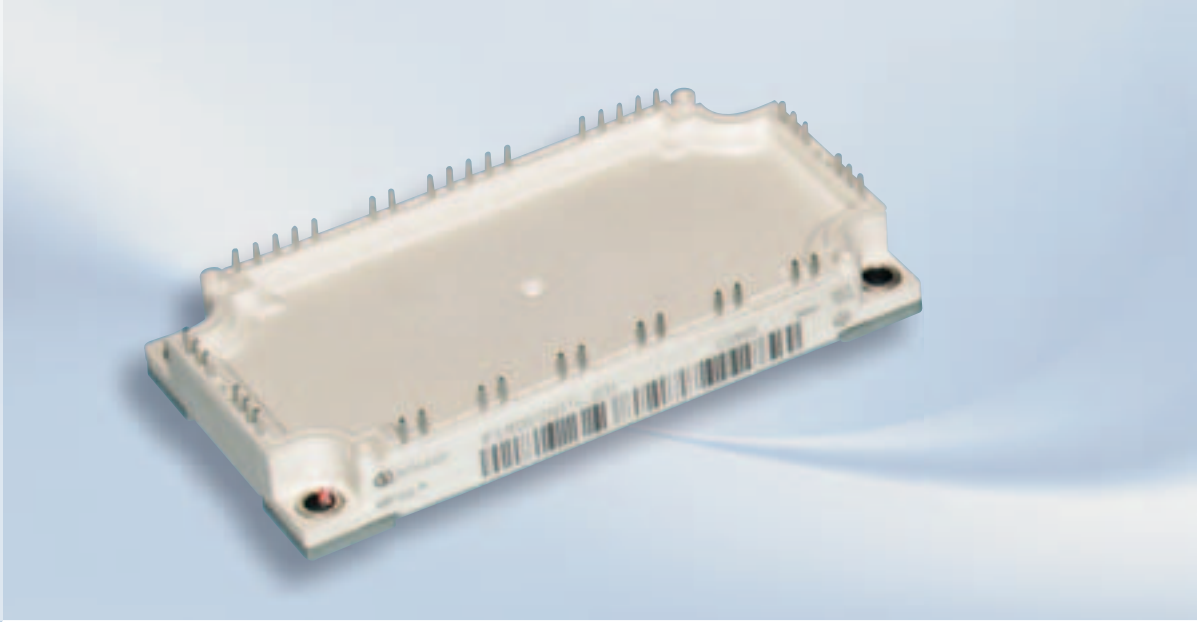
THE MIPAQ™ FAMILY is based on an innovative packaging concept and utilizes the advantages of the Infineon IGBT^4 chip technology. This technology makes it possible to increase the power density of IGBT modules. IGBT^4 does not only provide approximately 20% lower switching losses than IGBT^3 but also significantly higher power cycling capability.
The operation junction temperature of IGBT^4 is 150°C offering even more output power and higher reliability for a variety of applications.

Solder and PressFIT Mounting Technology

THE MIPAQ™ BASE is available with the well known solder terminals while the MIPAQ™ sense features PressFIT connections as state-of-the-art. The advantage of the PressFIT process is, that it can be separated from the soldering process and allows module mounting on soldering and component side of the PCB. This increases the design flexibility. The high reliability of PressFIT contacts in general increases the system reliability. This is especially of interest, if modules are operating in harsh environments.

Power Range





MIPAQ™ base

The Module with Integrated Shunts

Key Benefits

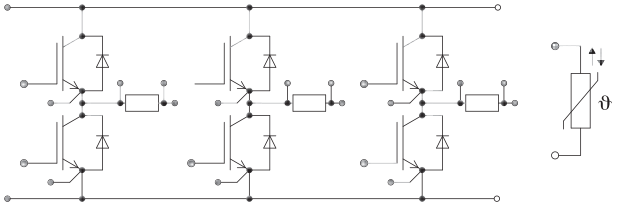
- Compact modules with a height of only 17mm allowing low-inductive system design
- Well-proven Econo design
- sixpack configuration with shunts and NTC
- Shunt values matched to rated chip current
- Allows accurate current sensing
- Up to 150A nominal current
- Saves space and system cost
- 150°C operation junction temperature
- Excellent power cycling capability
- High power density for compact inverter designs
- RoHS compliant

ONE OF THE FIRST family members is the MIPAQ™ base module featuring IGBT4. MIPAQ™ base provides an IGBT sixpack plus current sense shunts inside. Owing to the integration of specially designed shunts, the performance with regard to system cost is excellent. MIPAQ™ base modules in sixpack configuration with NTC are available in the well-proven EconoPACK™ 3 housing with 75A, 100A and even 150A nominal current and 1200V blocking voltage. MIPAQ™ base shunt modules save space, help to manage the temperature on the PCB while allowing very high measurement accuracy.

Integrating Shunts in a Power Module

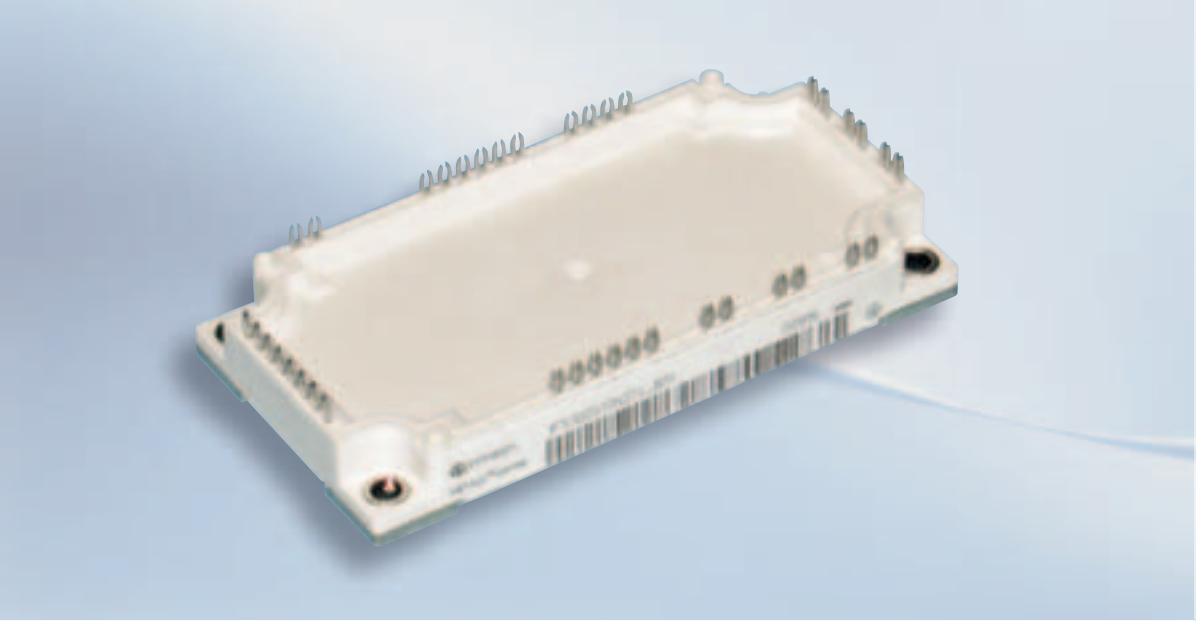
THE CLASSICAL METHOD to measure currents is using shunts. The voltage drop across the shunt, caused by the current to be determined, is measured. This solution has a known disadvantage as the resistor causes additional losses. Integrating current sensors into industrial drives usually is done by mounting the sensor to PCB. The thermal situation gets difficult, if currents in a range of up to hundred amperes occur. Due to the losses caused by the shunt in addition to heat coming from power electronic devices and from the PCB, temperatures beyond the level tolerable for PCB materials could be reached. Thus it is mandatory to place shunts in an area where the power losses can be dissipated easily. Including the shunts into a power module is leading to excellent thermal properties. Despite the temperature swing coming from the losses, the shunts in the MIPAQ™ base provide a linear relation between measured voltage and measured current across the whole range of current and temperature.

MIPAQ™ base
Circuit Diagram



Product Overview Type	V_{CES} V	I_C A	V_{CEsat} V T_{vj}=25°C typ.	P_{tot} W	R_{thjC} K/W max.	R_{shunt} mΩ T_{vj}=25°C typ.
IFS75B12N3T4_B31	1200	75	1,85	385	0,39	2,40
IFS100B12N3T4_B31	1200	100	1,75	515	0,29	1,50
IFS150B12N3T4_B31	1200	150	1,75	750	0,20	1,00

..._B31: Pin for solder connection

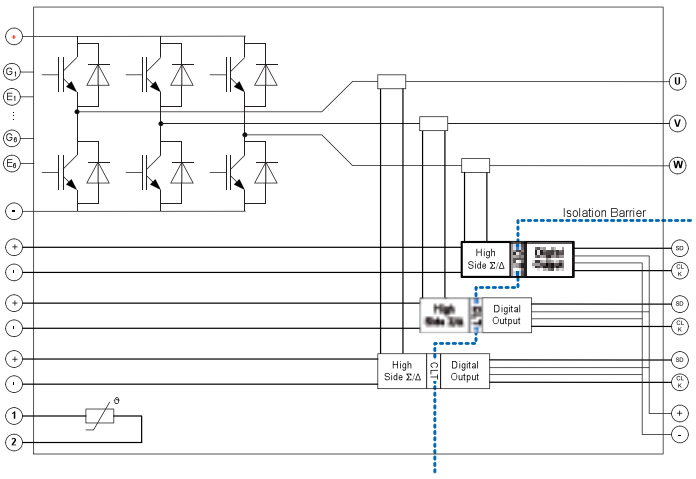


MIPAQ™ sense

The Module with Digital Current Measurement

IN ADDITION TO THE MIPAQ™ BASE with IGBT sixpack configuration and three highly sophisticated current shunts, the MIPAQ™ sense module also integrates a fully digital current measurement with galvanically isolated output signals using the Sigma Delta measurement method. With Infineon's Coreless Transformer Technology (CLT), optocouplers are no longer required, saving additional board space. The measurement integrated in the MIPAQ™sense provides accurate data for regulation purpose as well as information to handle over current situations. The MIPAQ™ sense modules manage currents of 75 A and 100 A. They are available in EconoPACK™ 3 housing using PressFIT interconnection technology for fast, reliable and solder-less mounting.

MIPAQ™ sense Functional Diagram



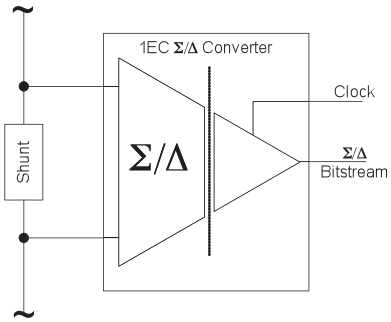
Key Benefits

- Compact modules with a height of only 17mm allowing low-inductive system design
- Well-proven EconoPACK™ 3 package plus current measurement electronics inside
- Up to 100A nominal current
- Highly sophisticated new current shunt included
- Sigma Delta method for current measurement inside
- Galvanically insulated current measurement signal by using Infineon Coreless Transformer Technology (CLT), i. e. no need for optocoupler
- Excellent accuracy and temperature stability
- Possibility to use current measurement with either high accuracy or short access time decided by software
- Saves board space in the application, due to integrated shunts and measurement electronic
- 150°C operation junction temperature
- Excellent power cycling capability
- High power density for compact inverter designs
- RoHS compliant

Sigma-Delta conversion for Current Measurement

ANY EQUIPMENT that connects the shunt to a microcontroller needs to be designed in a way that it separates control and power electronics. One common way to do so is to have the voltage across the shunt digitized using an A/D-converter that has its supply voltage referenced to the high side voltage. The A/D's digital information is then passed to the control by means of optoelectronic compounds. These elements are known to age under high temperature.
A sophisticated measurement system is using the Sigma-Delta (Σ/Δ) data conversion technology.
The technology offers a big advantage compared to conventional A/D converter solutions. It only needs two channels for data streaming and clocking. Both information lines easily can be galvanically isolated via Coreless Transformer (CLT) technology

Sigma-Delta conversion



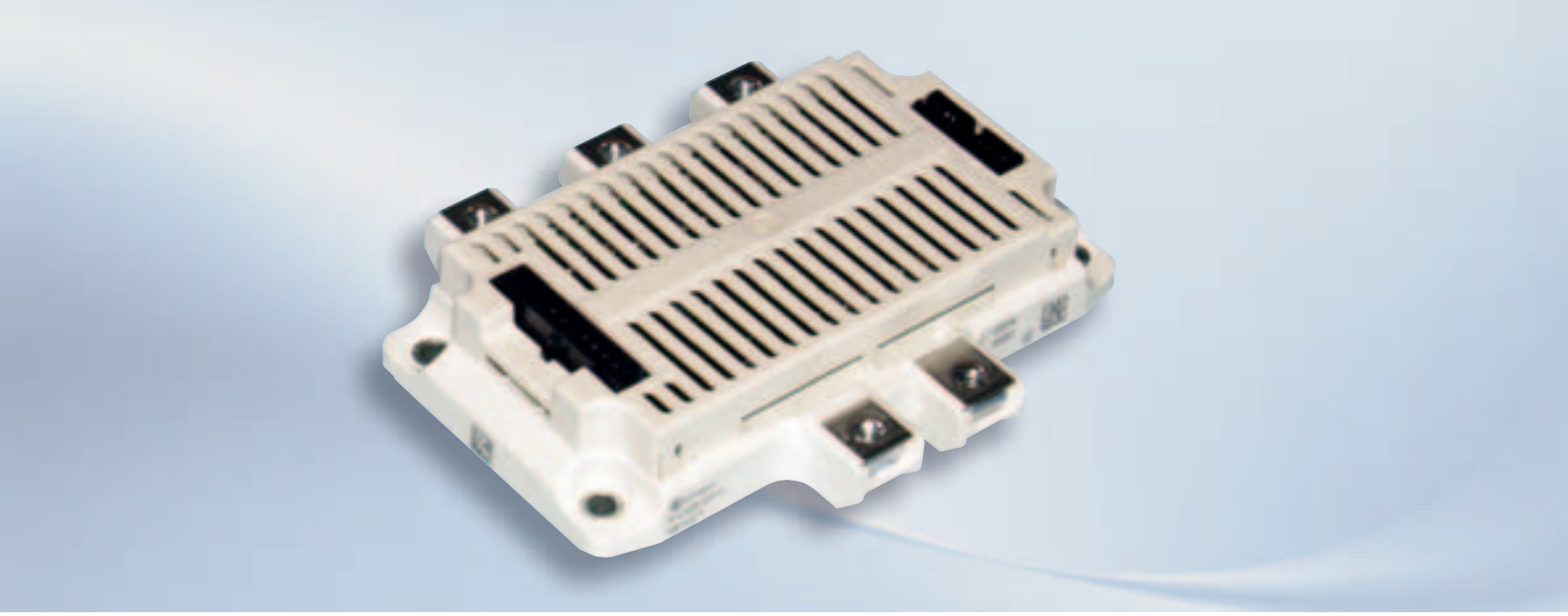
THE CLT IS WELL PROVEN in IGBT-Drivers and forms with the Sigma-Delta technology an interface to the integrated shunt. The task to be completed by this interface is to read out the electric value, transform it to digital information and transmit this information to the controller level providing galvanic isolation.

CORELESS TRANSFORMER technology is approved for temperatures up to 150°C and therefore an optimum solution to be integrated into a power electronic module.

ONE OF THE FEATURES of the Sigma-Delta conversion is the ability to trade speed for accuracy and vice versa. To generate a real measured value from the Sigma-Delta data stream, a decimator is necessary. This can be implemented as a logical function, e.g. as a sinc³ filter in a FPGA.

Product Overview Type	V_{CES} V	I_C A	V_{CEsat} V T_{vj}=25°C typ.	R_{shunt} mΩ T_{vj}=25°C typ.
IFS75S12N3T4_B11	1200	75	1,85	2,40
IFS100S12N3T4_B11	1200	100	1,75	1,50

..._B11 PressFIT Module



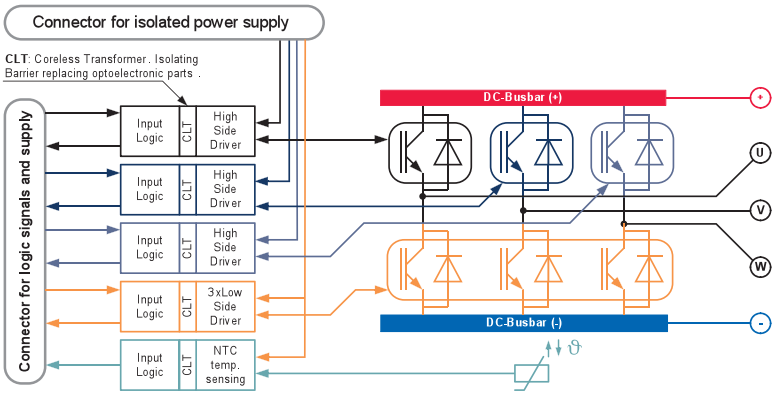
MIPAQ™ serve

The Module with Driver Electronics

MIPAQ™ SERVE is a highly reliable module integrating an IGBT sixpack configuration, a full set of driver ICs as well as a digital temperature measurement. These functionalities enable MIPAQ™ serve to be a full plug-and-play solution for high-current drive applications. Inside the module, there are galvanically isolated drivers based on Infineon's Coreless Transformer Technology. With the elimination of optical couplers, it will further enhance the modules' long-term stability. The MIPAQ™ serve modules, based on the newly designed EconoPACK™ 4 utilizing IGBT4, cover the 1200V range and manage currents of 100 A, 150 A and 200 A. High current connections are done by using screws. Standardized connectors are provided for supply voltage and logic signals for plug-and-play.

DUE TO THE INTEGRATION of CLT instead of optical couplers, the performance of this new module family with regard to cost and long term stability is excellent. Although electronics have been integrated into the module, it offers the same high reliability as all other Infineon's IGBT families.

MIPAQ™ serve Functional Diagram



Driver Electronics Inside

DESIGNING A PROPER CIRCUIT to drive a given IGBT module is one of the tasks that have to be done repeatedly binding resources, taking time and effort. This not only relates to choosing components and routing a layout, it also needs to be tested to the full extent to guarantee its function under all relevant module operating conditions. This time consuming process is eliminated as the MIPAQ™ serve already includes the 100% tested IGBT driver with the following characteristics:

- Proper driving of the IGBT by applying a sufficient gate pulse
- Turn off with negative gate voltage
- 5V Logic supply and 5V-CMOS-compatible
- Galvanic isolation towards the control electronics
- Short circuit protection
- Undervoltage lockout
- Active Miller clamping
- Error signal generation in case of failures
- Fully digital temperature measurement utilizing the internal NTC

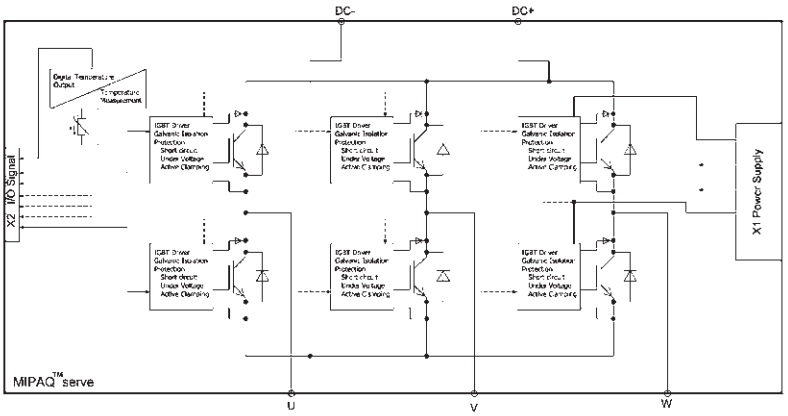
GALVANIC ISOLATION is achieved by implemented Coreless Transformer Technology (CLT). Short circuit is detected utilizing desaturation recognition. Error signals are generated in case of undervoltage or short circuit. The internal NTC is used to capture the base plate's temperature. The signal generated is transported to the logic via Coreless Transformer as well providing a galvanic separation for the temperature measurement. The isolation achieved with CLT today qualifies as functional isolation.

TO EASE ACCESS to the device, the interface consists of connectors according to industrial standards. They are used to connect the gate driver supply voltages as well as the logic supply, control and error signals.

Key Benefits

- EconoPACK™ 4 package
  plus driver on top saves board space in the application
- Up to 200A nominal current
- Designed for robustness: Ultrasonic welding technology; Injection molded DC-bus-bar, control pins and power terminals
- Highly sophisticated CLT included leads to improved system reliability due to elimination of optoelectronics
- True baseplate temperature measurement providing digital information to the user – galvanically separated
- Increasing both output power and efficiency due to optimized dead time
- Industrial standard connectors
- Plug & play solution for high current drives
- 150°C operation junction temperature
- RoHS compliant

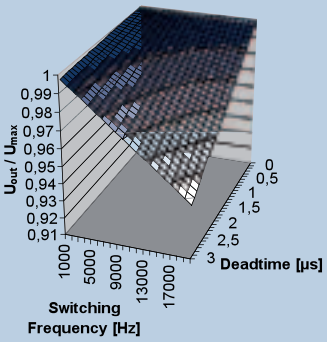
MIPAQ™ serve Internal Function Block Diagram



Increasing the inverter's output voltage

STANDARD DRIVER CIRCUITS often contain optoelectronic elements that show two major drawbacks. Optoelectronic components are known to age over time especially at higher temperature levels. The deviation of the propagation delay of commonly used optoelectronic gate driver circuits is in the range of up to 400ns. Due to safety concerns, the dead time implemented in many designs exceeds 2µs to ensure proper operation during the predicted lifetime. Within the MIPAQ™ serve the deviation between the six IGBT channels is drastically reduced. Turning on the six IGBTs with a single pulse reveals that all six gate voltages are synchronous within a tolerance of less than 20ns. This is the key to decreasing the dead time, necessary to prevent the risk of short circuit during the commutation. Reduced dead times lead to an increase in the inverter's output voltage increasing both its output power and efficiency.

Dependency of output voltage ratio vs. dead time and switching frequency



The EconoPACK™ 4 advantage

WITH THE ECONOPACK™ 4, Infineon introduced the new standard for highly reliable IGBT modules. The power section's internal construction is designed for increased reliability and improved thermal capabilities. The package based on the well-known Econo housing principle is characterized by its flat geometry. As a consequence of the higher power ratings, compared to the EconoPACK™ and EconoPIM™ modules, the main terminals are built as screw connections. These power terminals feature the so called flow through concept, similar to Infineon's EconoPACK™ +. One module side contains the screw terminals for the DC link and the opposite side of the package provides the screw terminals for the AC output connection. The module height reduces the demand of volume significantly while keeping the mounting procedure very easy. A relatively flat inverter structure is the result.

ULTRASONIC WELDING (USW) to replace frame bonding is one major step to increase the mechanical robustness. In-frame bus bars form a low inductive interface from the terminals to the semiconductors. The massive copper that is now used instead of bond wires reduces the resistance from the terminals to the DCB thereby decreasing the ohmic losses inside the module. Optimised gate driver connection is achieved by placing the driver on top of the module. PressFIT connections between module and PCB for the control section further increase the reliability as a gas-tight, low resistive, cold welded connection is achieved.

Product Overview MIPAQ™serve	V_{CES} V	I_C A	V_{CEsat} V T_{vj}=25°C typ.	R_{thjC} max K/W
IFS100V12PT4	1200	100	1,75	0,3
IFS150V12PT4	1200	150	1,75	0,22
IFS200V12PT4	1200	200	1,75	0,15

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